Preliminary Geotechnical Engineering Report

116 S. Henry Street
Alexandria, Virginia

July 18, 2017

Terracon Project No. EV175097

Prepared for:

General Services Administration
City of Alexandria, Virginia

Prepared by:

Terracon Consultants, Inc.
Woodbridge, Virginia

July 18, 2017

General Services Administration
City of Alexandria, Virginia

Attn: Mr. Donald Manthey
Capital Project Manager
City of Alexandria
P: [703] -746-3214

Re: 116 S. Henry Street
City of Alexandria Virginia
Terracon Project Number: EV175097

Dear Mr. Manthey:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. This preliminary study was performed in general accordance with our proposal number EV175097 dated June 5, 2017. This report presents the findings of the subsurface exploration; and, provides geotechnical engineering recommendations concerning earthwork, including deep foundation alternatives considering the proposed site development as informed by the City.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Xiwen Li

Xiwen Li, EIT
Staff Engineer

COMMONWEALTH OF VIRGINIA
EMAD E. SAADEH
Lic. No. 017719
JUL 18 2017
PROFESSIONAL ENGINEER

Emad Saadeh, P.E.
Regional Manager/Principal

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EXECUTIVE SUMMARY

Terracon has completed a subsurface investigation and a preliminary geotechnical engineering report for a composite of parcels at 112 S. Henry Street in the City of Alexandria, Virginia. Based on the information provided to us, we understand that a multistory parking structure with a below ground level is planned. It is our opinion that the site can be developed as planned, provided the recommendations included in this preliminary geotechnical report are followed. Should these assumptions may different, Terracon request the opportunity to revise this document to reflect the new proposed development. The following geotechnical considerations were identified:

- The existing parking lot and underground utility lines within this site shall be removed and/or properly abandoned during site development.
- Undocumented FILL soils were encountered in borings TB-1 and TB-3 to a maximum depth of 3 feet below existing grades.
- Natural fine-grained soils consisting of LEAN CLAY (CL) and SILT (ML) with varying amounts of sand were encountered at shallow depths, at depths ranging 3 and 15 feet. SILT soils (ML) were encountered at depths ranging between 53.5 and 83.5 feet below grade in the area where boring TB-2 was advanced. Natural loose and medium dense coarse-grained materials, including silty SAND (SM) and poorly graded SAND (SP) shall be expected at depths below 11 to 15 feet below existing grades, extending to the maximum depth drilled.
- Groundwater was encountered during drilling at depths ranging between 24.5 and 29 feet below existing grades. Based on this information, dewatering and other groundwater drainage methods shall be considered during design and construction phases of the project.
- The site is bound by existing buildings on north and south; and roadways on the east and west of the property. The load from the building and vehicular traffic from the roadways should be considered during planning and construction stages of the project
- An IBC seismic site classification of “D” is appropriate for this site
- Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. We therefore recommend that the Terracon be retained to monitor this portion of the work.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that all recommendations reflected in this report are preliminary, solely based on the projected site development. As a result, details were not included or fully developed as part of this report.

Therefore, the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

PRELIMINARY GEOTECHNICAL ENGINEERING REPORT
116 South Henry Street
City of Alexandria, Virginia
Terracon Project No. EV175097
July 18, 2017

1.0 INTRODUCTION

A subsurface exploration and a preliminary geotechnical study has been performed for a composite of parcels, identified herein as *116 S. Henry Street* in the *City of Alexandria*, *Virginia* (the project). The scope of our services was completed in accordance with Terracon Proposal/Agreement No. EV175097. The purpose of these services is to provide a summary of encountered subsurface conditions and preliminary geotechnical engineering considerations relative to:

- Subsurface Soil Conditions
- Groundwater Conditions
- Foundation Design and Construction
- Earthwork Considerations

2.0 PROJECT INFORMATION

2.1 Site Location and Description

Table 1. Site Location and Description

Item	Description
Location	116 S. Henry Street, City of Alexandria, Virginia
Current ground cover	Paved Area (Asphalt) and side walk with existing facilities
Existing topography	Approximate EL.40’ +/- (*)
Existing Utilities	Existing aerial and underground utility lines within this site
(*) Note.- Elevations are approximate as obtained from The National Map -Elevation Point Query Service.	

3.0 SUBSURFACE CONDITIONS

3.1 Geology

A review of published geological and soil information for the region indicates that the project site is geologically located within the *Coastal Plain Physiographic Province of Virginia*, mapped as the *Shirley Formation (Quaternary)*. It has interbedded gravel, sand, silt, clay, and peat; at altitudes to 35-45 ft. (top of unit).

Based on our review of the Soil Survey from United States Department of Agricultural[1], the in-situ soils are mapped as *Urban land-Grist Mill* (98) located on the whole area of the property. These soils are considered *Disturbed Soils* in which its traits, characteristic and taxonomy are changed significantly as compared to the natural soils from which they were created. The Grist Mill consist mostly of sandy, silty, and clayey sediments of the Coastal Plain that have been mixed, graded, and compacted during development and construction. Characteristics of the soil can be variable depending on what materials were mixed-in during construction. Generally, the soil has been compacted, and the soils are well drained.

A Soil Type Map (Exhibit A-3) has been prepared indicating the extent of these soils with respect of the overall property.

3.2 Typical Profile

Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

Table 2. Summary of Stratigraphy

Stratum	Borings	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
Asphalt	All	0-1		
Existing Man-placed FILL	TB-1 and TB-3	1 to 3	Uncontrolled FILL [1] consisting of LEAN CLAY (CL)	Medium Stiff
1	All	0 to 15	CLAYEY SAND (SC) only in boring TB-2 SILT (ML) and LEAN CLAY (CL)	Soft to very stiff / Loose to Medium dense;
2	All	13 to 53.5	SILTY SAND (SM) and POORLY GRADED SAND (SP)	Loose to medium dense
3	TB-2	53.5 – 83.5	SANDY SILT (ML)	Medium stiff to stiff
4	TB-2	83.5 – 100[2]	POORLY GRADED SAND WITH SILT (SP-SM)	Medium dense

1. *Uncontrolled FILL is material that was placed without moisture and density control. This material is typically variable in composition, consistency, density, moisture, and depth. It was difficult to discern between native soil and uncontrolled fill due to the disturbed sampling techniques and variation in color and composition.*
2. *See boring TB-2, the bottom of stratum is not determined.*

The upper soil encountered in the borings consisted of uncontrolled FILL generally comprised of a combination of coarse-grained clayey SAND (SC), and fine-grained LEAN CLAY (CL).

The majority of the soils at deeper elevations below 15 feet consist mostly of coarse-grained silty SAND (SM), clayey SAND (SC); and Poorly Graded SAND (SP). Conditions encountered at each boring location are indicated on the individual boring logs.

[1] https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in Appendix A of this report.

3.3 Groundwater

Groundwater and cave in depths were recorded during drilling. Groundwater was encountered at drilling completion in all borings at depths ranging between 24.5 and 29 feet below existing grades. Groundwater was not encountered 24 hours after drilling completion.

Cave-in depths recorded in all borings ranged between 20.5 and 30 feet below existing grades. These readings may be an indication of a groundwater table and not a perched water condition. Fluctuations in perched or groundwater levels should be expected with variations in conditions such as precipitation, evaporation, construction activity, etc.

3.4 SEISMIC CONSIDERATIONS

Design of the proposed building and other structures subject to earthquake ground motions, requires classification of the upper 100 feet of the site profile in accordance with Chapter 20 of ASCE 7. The Site Class types are listed below and are basically defined by an average value of either shear wave velocity, standard penetration resistance, or undrained shear strength.

- A. Hard Rock
- B. Rock
- C. Very dense soil and soft rock
- D. Stiff soil
- E. Soft clay soil
- F. Soils vulnerable to potential failure or collapse under seismic loading

Based on the results of our site characterization program, we conclude that **Site Class D** is appropriate for the subject site. Note that the scope of services did not include site profile determination to a depth of 100 feet. Explorations for this project extended to a maximum depth of 20 feet. Based on estimated shear wave velocities applicable to encountered subsurface conditions and our experience in the area, the site classification is based on the assumption that the soils encountered at the sounding termination depth, continue to a depth of 100 feet.

3.4.1 Seismic Evaluation

According to the International Building Code 2015 edition (IBC 2015), structures are required to avoid collapse during a design earthquake event. Seismic Site Class D would be applicable and the following seismic design parameters can be used for the site:

Table 3. Seismic Parameters Summary

Code Used	Site Classification
2012/2015 International Building Code (IBC)[1]	D[2]
Seismic Design Parameter	**Value[3]**
F_a	1.6
F_v	2.4
S_{DS}	0126g
S_{D1}	0.082g

1. *In general accordance with the 2012/2015 International Building Code and ASCE 7-10 Table 20.3-1, and an average weighted shear wave velocity of 840 feet per second.*
2. *Based upon the fundamental period exception outlined in ASCE 7-10 Section 20.3.1*
3. *Values are obtained from U.S. Seismic Design Maps (https://earthquake.usgs.gov/hazards/designmaps/usdesign.php)*

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Based on the results of the subsurface exploration, laboratory testing, and our analyses, it is our opinion that the project site is generally suitable for the construction of the planned multi-story parking structure, provided our specific recommendations are followed. Geotechnical considerations for this project include:

- Existing Uncontrolled FILL
- Limited Spacing
- Excavation adjacent to existing buildings and roadways

4.1.1 Existing Uncontrolled Fill

Existing man-placed FILL was encountered in borings TB-1 and TB-3. This material consisted mostly of LEAN CLAY (CL) soils with trace of gravel and brick soils. The depth of these fine-grained soils extended to a depth of 3 feet below existing grades, where they transitioned to coarse-grained silty SAND (SM) and/or clayey SAND (SC).

These soils shall be properly evaluated at the timer of excavation and, if deemed unsuitable by the Geotechnical Engineer of Records, these materials shall be removed in their entirety and replaced with suitable controlled fill that meets the requirements stated in **Section 4.2.2** of this report.

4.1.2 Groundwater

Based on the results of our subsurface exploration, groundwater was encountered in all borings during drilling, at depths ranging between 24.5 and 29 feet below current grade as indicated in the individual boring logs attached as part of the Appendix of this report. Dewatering and drainage methods shall be required during construction.

4.1.3 Excavation adjacent to the buildings

As the site with limit spacing for excavation and spread footing, temporary shoring sheeting and shoring for deep excavations, and deep foundation should be applied to this project. The details have been included in **Section 4.3** and **Section 4.5** of this report.

4.2 Earthwork

4.2.1 Site Preparation

All areas proposed for cut shall be cleared, grubbed and stripped of existing paved materials, underground utility lines, facilities, or any other deleterious or unsuitable material within the proposed limits of construction as shown on the approved plans for this project.

We anticipate that conventional earth-moving equipment, equivalent to a CAT 963 front-end loader and CAT 325 backhoe will be suitable for the excavation of the on-site soils, to the depths indicated in the borings.

Temporary excavations greater than 4 feet shall be properly shored or sloped away from the excavation with a minimum grade of 1.5H to 1.0V (horizontal to vertical). If sloping of utility trenches and pits is not desired, then trench boxes shall be utilized. All excavations shall be performed in accordance with the OSHA and VOSHA regulations.

4.2.2 Material Requirements

Compacted structural fill should meet the following requirements:

Table 4. Borrow Material Requirements

Fill Type	USCS Classification	Acceptable Location for Placement
Borrow Material	See details of this section	TBD
On-site soils[5]	Natural Granular Soils (SC, SM)	N/A

All borrow material, whether on-site or imported from an off-site source, shall be tested for suitability and quality prior to its use as fill or backfill. The material shall be tested to determine particle gradation, plasticity and maximum dry density. The following standard tests shall be performed to determine the above properties of all imported fill material:

Determination of Moisture Content of Soils	ASTM D-2216
Particle Size Analysis of Soils	ASTM D-422
Atterberg Limits	ASTM D-4318
Standard Proctor Test	VTM-1, ASTM D-698

Structural fill material shall consist of quality, free of organic, low plasticity soil that classify as GW, GP, GM, GC, SW, SP, SC, CL, ML or SM in accordance with ASTM D-2487. All fill material shall be free of ice, snow, topsoil, trash, construction debris, rock sizes greater than 4 inches, or other deleterious material.
All fill materials shall have a Plasticity Index (PI) value less than 15 and meet the suitability requirements stated in IBC 2012 Section 1803.5.3 Expansive Soils Classification. In addition, natural on-site or borrowed off-site soils having: (i) a PI value more than 14 determined in accordance with ASTM D-4318, (ii) with more than 10% of soil particles passing the # 200 sieve as determined in accordance with ASTM D-422; and, (iii) with more than 10% of the soil particles are less than 5 micrometers in size as determined in accordance with ASTM D-422; or, (iv) an Expansion Index value greater than 20 per ASTM D-4829, <u>are considered unsuitable for use as compacted structural fill</u> for the support of building foundations in the Active Zone, per the 2012 International Building Code (IBC), Section 1802.3.2 Expansive Soils Classifications.

These unsuitable materials includes high plasticity CLAY (CH) or elastic SILT (MH). These soils are known to exhibit high shrink-swell and plastic behavior. Where encountered during site grading, these high plasticity materials should be excavated and separated from the remaining sandy soils.

4.2.3 Compaction Requirements

Table 5. Fill Compaction Requirements

Item	Description
Fill Lift Thickness	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used
Compaction Requirements	95% of the material's maximum standard Proctor dry density (ASTM D 698). Up to 100% for fills of more than 10 feet.
Moisture Content – Cohesive Soil	Within range of optimum moisture content to 2% above optimum moisture content as determined by the standard Proctor test at the time of placement and compaction
Moisture Content – Granular Material	Workable moisture levels

The controlled fill to be placed on roadways shall extend a minimum of 2 feet laterally outside the curb line plus 1 foot for every foot of fill above the subgrade.

To ensure proper compaction efforts, field density determinations should be performed in accordance with specifications set forth in ASTM D-6938 (Nuclear Method) or D-1556 (Sand Cone Method).

Compaction tests should be performed on every lift of fill placed. These tests should be performed at a minimum frequency of three (3) tests for every lift of fill placed for the building pad.

All earthwork shall be monitored on a full-time basis by a qualified inspector, acting under the guidance of a Professional Engineer, registered in the Commonwealth of Virginia.
The Geotechnical Engineer of Record shall complete all required testing and in-situ evaluation to ensure that these materials meet the requirements stated in this Section. Some soils may be wet or dry of the optimum moisture required for compaction; therefore, scarifying and drying by spreading and aerating or the use of a water truck during construction and prior to their reuse as compacted structural fill or backfill should be expected.

4.2.4 Utility Trench Backfill

Excavations for underground utility trenches may encounter groundwater seepage. Therefore, the site contractor should be prepared to provide temporary dewatering measures, such as sump pits or continuous pumping. Temporary excavations greater than 4 feet for site utilities should be properly shored or sloped away from the excavation with a minimum grade of 1.5H:1V.

If sloping of temporary utility trenches and pits is not desired, then trench boxes should be utilized. All excavations should be performed in accordance with the current OSHA and VOSHA regulations. When hand-held tampers are used to compact the backfill materials, lift thickness should be reduced to not more than 6 inches to achieve a compacted wedge between the pipe and the bedding layer.

All loose materials encountered at the utility pipe subgrade shall be removed. The pipe subgrade should be observed and probed for suitability under the supervision of a Virginia -registered professional engineer or an approved representative. The professional engineer or his assigned representative shall also observe earthwork and perform necessary tests and observations during subgrade preparation; to monitor proofrolling, placement and compaction of controlled compacted fills, and backfilling.

4.2.5 Grading and Drainage

Effective drainage should be provided during construction and maintained throughout the life of the development to prevent an increase in moisture content of the foundation of proposed structures, pavement and backfill materials. Surface water drainage should be controlled to prevent undermining of structures during and after construction. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Construction staging should provide drainage of surface water and precipitation away from the building and pavement areas.

Any water that collects over or adjacent to construction areas should be promptly removed, along with any softened or disturbed soils. Surface water control in the form of sloping surfaces, drainage ditches and trenches, and sump pits and pumps will be important to avoid ponding and associated delays due to precipitation and seepage.

All temporary excavations greater than 4 feet deep that may be required during construction, should comply with applicable local, state and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards to provide stability and safe working conditions. Cut/fill slopes may be used in conjunction with the site grading plan.

According to **Section 3.3** of this report, groundwater should be anticipated to be encountered during general earthwork construction activities at depth greater than 8 feet below ground surface. If encountered, groundwater can be handled through temporary dewatering methods, i.e. sump pits and continuous pumping, especially if work is planned during the wet period of the year.

4.3 Foundations

As of the time of this preliminary report, specific information regarding the proposed construction is not available. These include the possible presence of below grade construction, the number of stories planned and the expected structural loading. However, considering encountered site conditions and the fact that the project will consist of a multi-story parking garage, we could provide preliminary recommendations for a deep foundation system to support the planned construction.

4.3.1 Deep Foundation Design Recommendations (Optional)

For the purposes of these recommendations, we estimate the parking garage will consist of post-tensioned concrete on grade construction with a maximum of three levels above grade. Straight drilled shafts are considered suitable for support of this multi-story structure. Based on our analysis of encountered subsurface conditions, shafts consisting of 24 to 30-inches utilizing skin friction and end-bearing could be utilized for the support of the structure. We recommend drilled shaft rather than driven pre-cast pre-stressed shaft due to the possible excessive vibration to adjacent structures and noise disturbance to businesses in the commercial strip adjoining the property. We have estimated each shaft will support up to 22 tons when taken to 40 feet below grade. An uplift capacity developed from skin friction is expected at 8 tons per shaft at each location. An improvement in the bearing capacity and available skin friction could be realized when these shafts are grouped in three or more shafts per group.

We anticipate that groundwater will be encountered during drilling operations at depth greater than 20 feet below ground surface. The boring logs showed water at depths greater than 30 feet could be misleading as the drilling was performed during the summer with extended low rain fall events. We recommend the drilled holes be cased to provide a shield against sidewall collapse and cave-in problems.

Concrete may be placed using a direct fall method, as long as the concrete is not allowed to strike the sides of the caisson liner, or any reinforcing steel. If concrete free falls and strikes obstructions, it can segregate, resulting in undesirable strength properties. Otherwise, it has been our experience that the free fall method of installation results in compact concrete.
Near the surface, the use of vibratory equipment to further consolidate the concrete would be appropriate. Since temporary liners are required both for the groundwater and for inspection purposes, concrete may be placed using a “pour and pull” technique. In this operation, it is critically important that the depth of the concrete be monitored to insure positive pressure of concrete as the liner is extracted. During placement operations, the elevation of the concrete should be monitored. At no time should the relative elevation of the concrete increase during extraction.

This implies that the concrete is adhering to the shaft of the liner, which can result in a vacuum pressure, resulting in contamination of the caisson shaft. If it is expected that any caisson shafts are contaminated in this method, then it will be necessary to core drill the caisson, to determine shaft integrity.

An alternative to deep foundation, mat foundation could be considered for the support of the structure. Preliminarily, a post tensioned; 18-inch minimum thickness; concrete mat will provide safe support based on and expected soil subgrade reaction of 125 pounds per cubic inch.

The final selection and greater details of the safest and most economical foundation system will be provided upon confirmation of the planned levels in the garage, the loading order and whether below grade parking is planned.

4.4 Floor Slabs

4.4.1 Floor Slab Design Recommendations

Table 6. Floor Slab Recommendation

Item	Description
Floor slab support	Low to medium plasticity natural granular soils or on approved compacted structural fill [1]
Modulus of subgrade reaction	60 pounds per square inch per inch (psi/in) for point loading conditions
Aggregate base course/capillary break	4 inches of free draining granular material[2]

1. *If the visual inspection of the sub-grade material and/or soil borings recovered material reveals the presence of fine-grained soils, i.e. CH or MH, we recommend that a sample of the soil sub-grade be tested to ensure that high plasticity soils.*
2. *In areas of the floor slab where loads are in excess of 500 psf, we recommend the granular material beneath the floor be increased to a minimum thickness of 6 inches, and additional reinforcing steel be placed in the floor slab.*

4.4.2 Floor Slab Construction Considerations

In addition, we recommend that wire mesh or fiber mesh reinforcement be included in the slab design. This reinforcement will minimize the crack width of any shrinkage cracks that may develop near the surface of the floor slab. A 6-mm polyethylene liner or similar vapor barrier should be provided between the underside of the slab and the granular base to limit moisture migration. Slab-on-grade sub-grades shall be inspected by the Geotechnical Engineer or his designated representative for suitability and firmness prior to placement of the granular layer.

If the garage is planned with below grade level(s), the slab will have to be provided with peripheral and lateral below slab drains connected to a sump pump with adequate back-up system in order to maintain groundwater below the slab and the potential for basement flooding. This feature will also be designed as part of the final design documents for the project.

4.5 Retention System

The foundation construction shall require temporary shoring sheeting and shoring for deep excavations of the proposed building. Sheeting and shoring methods should be considered to brace the proposed face of cut for the proposed below-grade levels.

Based on the above and considering the preliminary nature of this study, specific recommendations for design and construction of these methods are not included. However, due to the depth of the required excavation for the construction of a lower level parking lot and the proximity of the excavation to existing structures and roadways, a temporary excavation support system shall be required.

Considering the site location and based on our experience with similar projects, we recommend that the retention systems be installed only in the areas adjacent to public roads and adjacent buildings. We believe this measure would represent a more cost effective option for the construction of the below grade structures.

We recommend that this system consist of soldier piles and wood lagging, braced with either tiebacks anchored in the adjacent overburden soils, or kickers and cross lot braces placed within limits of the excavation. The soldier beam and wood lagging retention system should be freely draining, and designed to withstand lateral earth pressures of at least 35 psf per foot of wall height. The influence of any surcharge loads should also be considered. This may consist of any additional lateral load transmitted by adjacent roadways.

The contractor should avoid stockpiling excavated materials or equipment immediately adjacent to the excavation walls. We recommend that stockpiled materials be kept back from the excavation a minimum distance equal one-half (½) the excavation depth to limit surcharging the excavation walls. If this is impractical due to space constraints, the excavation walls should be retained with bracing designed for the anticipated surcharge load. In addition, the earth retention system design should consider surcharge loads from cranes and other construction equipment during construction as well as buildings.

The spacing of the soldier piles and braces should be determined by a structural analysis. The design of the retention system is beyond this scope of work; however, we recommend that the maximum center-to-center spacing of soldier piles not exceed 8 feet. In addition, the wood lagging should have a minimum thickness of three inches. In most areas, tieback anchors appear feasible for bracing of the sheeting. Soldier piles should be driven a sufficient distance so that the earth retention system will not become undermined if it becomes necessary to step down perimeter footings up to 2 feet.

If tiebacks are used, we recommend that a performance test be conducted. The performance test is used to evaluate the tieback load carrying capacity, deflections during loading, and movements with respect to time. The load should be applied by means of a hydraulic center-hole jack in load increments equal to 25%, 50%, 75%, 100%, 120% and 133% of the design load. The tieback capacity should be considered adequate when a stable condition is obtained under a particular test load for load duration of 15 minutes.

Another system that has been used in this area is a slurry wall system. A slurry wall is typically constructed using a special clam shell and bucket system, with a slurry material to maintain the open excavation. Reinforcing steel is lowered into the excavation, and the concrete of the slurry wall is pumped into place suing a displacement technique. Although the slurry wall is often considerably more expensive that other conventional earth retention systems, the slurry wall could also be used as a permanent exterior wall for the building, although some cosmetic improvement of the interior face of the building would be necessary.

In the event a permanent slurry wall is installed on one or more sides of the building, the slurry wall should be designed for lateral earth pressures previously recommended plus surcharge loads due to foundations.

As we have stated, the design of an earth retention system is beyond the scope of this report. However, Terracon has considerable experience in the design and evaluation of permanent below grade earth retention systems and would be pleased to assist in the design of a slurry wall, if such a system is selected, or in the review of other systems or methods that may be designed by others.

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A

FIELD EXPLORATION

TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
QUADRANGLES INCLUDE: ALEXANDRIA, VA (1/1/1994).

Project Manager: XL	Project No. EV175097	Terracon	SITE LOCATION	Exhibit
Drawn by: XL	Scale: 1"=2,000'	4899 Prince William Pkwy	116 Henry Street	A-1
Checked by: ES	File Name:	Woodbridge, VA 22192-5434	Alexandria, VA	
Approved by: ES	Date: 07/17/2017			

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

Project Manager: XL	Project No. EV175097	Terracon 4899 Prince William Pkwy Woodbridge, VA 22192-5434	BORING LOCATION PLAN	Exhibit
Drawn by: XL	Scale: AS SHOWN		116 Henry Street	A-2
Checked by: ES	File Name:		Alexandria, VA	
Approved by: ES	Date: 07/17/2017			

N

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

RESOURCE:
https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

Project Manager: XL	Project No. EV175097	Terracon 4899 Prince William Pkwy Woodbridge, VA 22192-5434	SOIL TYPE MAP	Exhibit
Drawn by: XL	Scale: AS SHOWN		116 Henry Street	A-3
Checked by: ES	File Name:		Alexandria, VA	
Approved by: ES	Date: 07/17/2017			

BORING LOG NO. TB-1 H

PROJECT: 116 South Henry Street

SITE: 112 South Henry Street
Alexandria, Virginia

CLIENT: Capital Projects Division
City of Alexandria, Virginia

LOCATION See Exhibit A-2

Latitude: 38.805084° Longitude: -77.0505679°

Approximate Surface Elev: 40 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)
0.3	**ASPHALT**	39.5+/-
0.9	**FILL - AGGREGATE BASE COURSE**, road base layer	39+/-
3.0	**FILL - LEAN CLAY (CL)**, trace gravel, dark gray, soft	37+/-
11.0	**LEAN CLAY (CL)**, brown, soft to very stiff	29+/-
15.0	**SANDY SILT (ML)**, light brown, medium stiff	25+/-
	SILTY SAND (SM), light brown to light orange, medium dense	

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1-3		X	5-2-1-1 N=3		
3-5		X	4-1-2-6 N=3		
5-7		X	5-9-13-17 N=22		
7-9		X	7-12-13-17 N=25		
9-11		X	6-6-7-8 N=13		
11-13		X	3-3-4-6 N=7		
13-15		X	1-3-4-4 N=7		
15-17		X	5-6-11-13 N=17	4	NP
18.5-20		X	4-8-8 N=16		
22	Upon Completion				
23.5-25		X	5-6-6 N=12		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.
Sealed with bituminous cold patch at surface.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevation obtained from The National Map - Elevation Point Query Service.

Notes:

WATER LEVEL OBSERVATIONS

While Dry Drilling

Upon Completion

Terracon
4899 Prince William Pkwy
Woodbridge, VA

Boring Started: 6/27/2017	Boring Completed: 6/27/2017
Drill Rig: CME-55	Driller: Recon
Project No.: EV175097	Exhibit: A-4

BORING LOG NO. TB-1 H

PROJECT: 116 South Henry Street

CLIENT: Capital Projects Division City of Alexandria, Virginia

SITE: 112 South Henry Street Alexandria, Virginia

LOCATION See Exhibit A-2

Latitude: 38.805084° Longitude: -77.0505679°

Approximate Surface Elev: 40 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
	SILTY SAND (SM), light brown to light orange, medium dense *(continued)*							
	wet			▽	X	4-5-8 N=13		
	30.0	10+/-	30					
	Boring Terminated at 30 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.
Sealed with bituminous cold patch at surface.

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Elevation obtained from The National Map - Elevation Point Query Service.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While Dry Drilling*

Upon Completion

Terracon
4899 Prince William Pkwy
Woodbridge, VA

Boring Started: 6/27/2017	Boring Completed: 6/27/2017
Drill Rig: CME-55	Driller: Recon
Project No.: EV175097	Exhibit: A-4

BORING LOG NO. TB-2 H

PROJECT: 116 South Henry Street

CLIENT: Capital Projects Division City of Alexandria, Virginia

SITE: 112 South Henry Street Alexandria, Virginia

LOCATION See Exhibit A-2

Latitude: 38.8050772° Longitude: -77.0510105°

Approximate Surface Elev: 40 (Ft.) +/-

DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
0.3		39.5+/-						
0.9	**FILL - AGGREGATE BASE COURSE**	39+/-						
	LEAN CLAY (CL), light brown to light orange, stiff to very stiff				X	6-5-5-7 N=10		
					X	5-6-10-13 N=16		
			5		X	4-9-11-14 N=20		
7.0		33+/-						
	CLAYEY SAND (SC), light brown to light orange, loose to medium dense				X	4-5-6-6 N=11		
			10		X	4-7-5-5 N=12		
					X	4-4-6-8 N=10		
13.0		27+/-						
	SILTY SAND (SM), trace gravel, light brown, loose to medium dense				X	5-9-9-8 N=18		
			15		X	4-5-6-6 N=11		
					X	5-8-7 N=15		
			20					
			25		X	5-4-7 N=11		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.
Sealed with bituminous cold patch at surface.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevation obtained from The National Map - Elevation Point Query Service.

Notes:

WATER LEVEL OBSERVATIONS

While Dry Drilling

Upon Completion

Terracon
4899 Prince William Pkwy
Woodbridge, VA

Boring Started: 6/28/2017	Boring Completed: 6/28/2017
Drill Rig: CME-55	Driller: Recon
Project No.: EV175097	Exhibit: A-5

BORING LOG NO. TB-2 H

PROJECT: 116 South Henry Street	CLIENT: Capital Projects Division City of Alexandria, Virginia
SITE: 112 South Henry Street Alexandria, Virginia	

LOCATION See Exhibit A-2

Latitude: 38.8050772° Longitude: -77.0510105°

Approximate Surface Elev: 40 (Ft.) +/-

GRAPHIC LOG	DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
	SILTY SAND (SM), trace gravel, light brown, loose to medium dense *(continued)*						
			▽	X	4-5-6 N=11		
	wet	30	Upon Completion				
				X	3-4-4 N=8		
		35					
				X	4-3-3 N=6		
		40					
				X	2-3-3 N=6		
		45					
				X	3-5-6 N=11	37	NP
		50					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method: Hollow Stem Auger Abandonment Method: Borings backfilled with soil cuttings upon completion. Sealed with bituminous cold patch at surface.	See Exhibit A-3 for description of field procedures. See Appendix B for description of laboratory procedures and additional data (if any). See Appendix C for explanation of symbols and abbreviations. Elevation obtained from The National Map - Elevation Point Query Service.	Notes:

WATER LEVEL OBSERVATIONS	Terracon 4899 Prince William Pkwy Woodbridge, VA	Boring Started: 6/28/2017	Boring Completed: 6/28/2017
▽ While Dry Drilling		Drill Rig: CME-55	Driller: Recon
Upon Completion		Project No.: EV175097	Exhibit: A-5

BORING LOG NO. TB-2 H

PROJECT: 116 South Henry Street

SITE: 112 South Henry Street Alexandria, Virginia

CLIENT: Capital Projects Division City of Alexandria, Virginia

LOCATION See Exhibit A-2

Latitude: 38.8050772° Longitude: -77.0510105°

Approximate Surface Elev: 40 (Ft.) +/-

GRAPHIC LOG	DEPTH / DESCRIPTION / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
	SILTY SAND (SM), trace gravel, light brown, loose to medium dense *(continued)*						
	53.5 — -13.5+/-						
	SANDY SILT (ML), dark gray, wet, medium stiff to stiff			X	2-3-3 N=6		
		55					
				X	3-6-6 N=12		
		60					
				X	4-6-7 N=13		
		65					
				X	2-2-4 N=6		
		70					
				X	3-2-4 N=6		
		75					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.
Sealed with bituminous cold patch at surface.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevation obtained from The National Map - Elevation Point Query Service.

Notes:

WATER LEVEL OBSERVATIONS

While Dry Drilling

Upon Completion

Terracon
4899 Prince William Pkwy
Woodbridge, VA

Boring Started: 6/28/2017	Boring Completed: 6/28/2017
Drill Rig: CME-55	Driller: Recon
Project No.: EV175097	Exhibit: A-5

BORING LOG NO. TB-2 H

PROJECT: 116 South Henry Street

SITE: 112 South Henry Street Alexandria, Virginia

CLIENT: Capital Projects Division City of Alexandria, Virginia

LOCATION See Exhibit A-2

Latitude: 38.8050772° Longitude: -77.0510105°

Approximate Surface Elev: 40 (Ft.) +/-

GRAPHIC LOG	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
		SANDY SILT (ML), dark gray, wet, medium stiff to stiff *(continued)*							
				80		X	4-5-5 N=10		
	83.5		-43.5+/-						
		POORLY GRADED SAND WITH SILT (SP-SM), dark gray, wet, medium dense							
				85		X	2-5-6 N=11		
				90		X	4-5-8 N=13		
				95		X	6-8-11 N=19		
	100.0		-60+/-	100		X	4-6-7 N=13		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.
Sealed with bituminous cold patch at surface.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevation obtained from The National Map - Elevation Point Query Service.

Notes:

WATER LEVEL OBSERVATIONS

While Dry Drilling

Upon Completion

Terracon
4899 Prince William Pkwy
Woodbridge, VA

Boring Started: 6/28/2017	Boring Completed: 6/28/2017
Drill Rig: CME-55	Driller: Recon
Project No.: EV175097	Exhibit: A-5

BORING LOG NO. TB-2 H

PROJECT: 116 South Henry Street

CLIENT: Capital Projects Division City of Alexandria, Virginia

SITE: 112 South Henry Street Alexandria, Virginia

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 38.8050772° Longitude: -77.0510105° Approximate Surface Elev: 40 (Ft.) +/- DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
	Boring Terminated at 100 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.
Sealed with bituminous cold patch at surface.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevation obtained from The National Map - Elevation Point Query Service.

Notes:

WATER LEVEL OBSERVATIONS

While Dry Drilling

Upon Completion

Terracon
4899 Prince William Pkwy
Woodbridge, VA

Boring Started: 6/28/2017	Boring Completed: 6/28/2017
Drill Rig: CME-55	Driller: Recon
Project No.: EV175097	Exhibit: A-5

BORING LOG NO. TB-3 H

PROJECT: 116 South Henry Street

CLIENT: Capital Projects Division City of Alexandria, Virginia

SITE: 112 South Henry Street Alexandria, Virginia

LOCATION See Exhibit A-2

Latitude: 38.8050747° Longitude: -77.0513075°

Approximate Surface Elev: 40 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)
0.3		39.5+/-
0.9	**FILL - AGGREGATE BASE COURSE**	39+/-
3.0	**FILL - LEAN CLAY (CL)**, light brown, soft	37+/-
11.0	**LEAN CLAY (CL)**, light brown, medium stiff to very stiff	29+/-
	SILTY SAND (SM), with clay seams, light brown with gray, very loose to medium dense wet (at approx. 24 ft)	

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
1-3		X	2-2-2-4 N=4		
3-5		X	4-3-4-5 N=7		
5-7		X	6-8-13-14 N=21		
7-9		X	6-6-4-6 N=10		
9-11		X	3-3-3-4 N=6		
11-13		X	4-5-5-4 N=10		
13-15		X	2-2-2-2 N=4		
15-17		X	2-3-3-4 N=6		
18.5-20		X	3-3-4 N=7		
20.5	Upon Completion				
23.5-25	While Dry Drilling	X	3-2-3 N=5		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.
Sealed with bituminous cold patch at surface.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevation obtained from The National Map - Elevation Point Query Service.

Notes:

WATER LEVEL OBSERVATIONS

While Dry Drilling

Upon Completion

Terracon
4899 Prince William Pkwy
Woodbridge, VA

Boring Started: 6/28/2017	Boring Completed: 6/28/2017
Drill Rig: CME-55	Driller: Recon
Project No.: EV175097	Exhibit: A-6

BORING LOG NO. TB-3 H

PROJECT: 116 South Henry Street

CLIENT: Capital Projects Division City of Alexandria, Virginia

SITE: 112 South Henry Street Alexandria, Virginia

LOCATION See Exhibit A-2

Latitude: 38.8050747° Longitude: -77.0513075°

Approximate Surface Elev: 40 (Ft.) +/-

GRAPHIC LOG	DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI
	SILTY SAND (SM), with clay seams, light brown with gray, very loose to medium dense *(continued)*						
	30.0 / 10+/-	30		X	4-5-6 N=11		
	Boring Terminated at 30 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.
Sealed with bituminous cold patch at surface.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevation obtained from The National Map - Elevation Point Query Service.

Notes:

WATER LEVEL OBSERVATIONS

While Dry Drilling

Upon Completion

Terracon
4899 Prince William Pkwy
Woodbridge, VA

Boring Started: 6/28/2017	Boring Completed: 6/28/2017
Drill Rig: CME-55	Driller: Recon
Project No.: EV175097	Exhibit: A-6

Field Exploration Description

The proposed boring locations were laid out in the field by a geotechnical engineer or his assigned representative measuring the locations from existing features. The borings were drilled with CME 550 ATV-mounted rotary drill rig using hollow-stem augers to advance the boreholes. Samples of the soil encountered in the borings were obtained using the split-barrel sampling procedures.

In the split-barrel sampling procedure, the number of blows required to advance a standard 2-inch O.D. split-barrel sampler the last 12 inches of the typical total 18-inch penetration by means of a 140-pound hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N). This value is used to estimate the in situ relative density of cohesionless soils and consistency of cohesive soils.

A CME automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this site. A significantly greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. This higher efficiency has an appreciable effect on the SPT-N value. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Information provided on the boring logs attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions. The borings were backfilled with auger cuttings prior to the drill crew leaving the site.

A field log of each boring was prepared by staff engineer of Terracon. These logs included visual classifications of the materials encountered during drilling as well as the driller's interpretation of the subsurface conditions between samples. Final boring logs included with this report represent the engineer's interpretation of the field logs and include modifications based on laboratory observation and tests of the samples.

APPENDIX B

LABORATORY TESTING

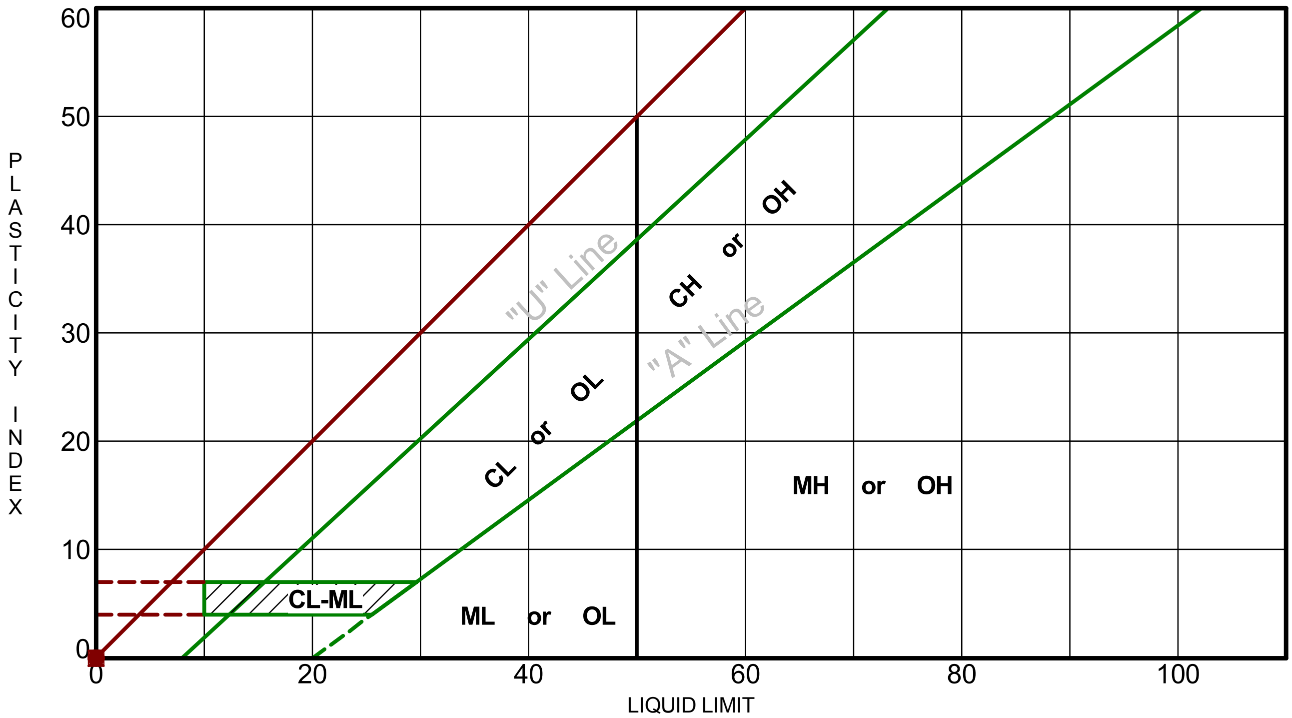
Laboratory Testing

Soil samples were tested in the laboratory to measure their natural water content. A calibrated hand penetrometer was used to estimate the approximate unconfined compressive strength of some samples. The calibrated hand penetrometer has been correlated with unconfined compression tests and provides a better estimate of soil consistency than visual examination alone. The test results are provided on the boring logs included in Appendix A.

Descriptive classifications of the soils indicated on the boring logs are in accordance with the enclosed General Notes and the Unified Soil Classification System. Also shown are estimated Unified Soil Classification Symbols. A brief description of this classification system is attached to this report. All classification was by visual manual procedures. Selected samples were further classified using the results of Atterberg limit testing. The Atterberg limit test results are also provided on the boring logs.

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID	Depth	LL	PL	PI	Fines	AASHTO	Description
● **TB-1 H**	**15 - 17**	**NP**	**NP**	**NP**	**3**	**A-3 (0)**	**POORLY GRADED SAND**
⊠ **TB-2 H**	**48.5 - 50**	**NP**	**NP**	**NP**	**36**	**A-4 (0)**	**SILTY SAND**

PROJECT: 116 South Henry Street

SITE: 112 South Henry Street
Alexandria, Virginia

Terracon
4899 Prince William Pkwy
Woodbridge, VA

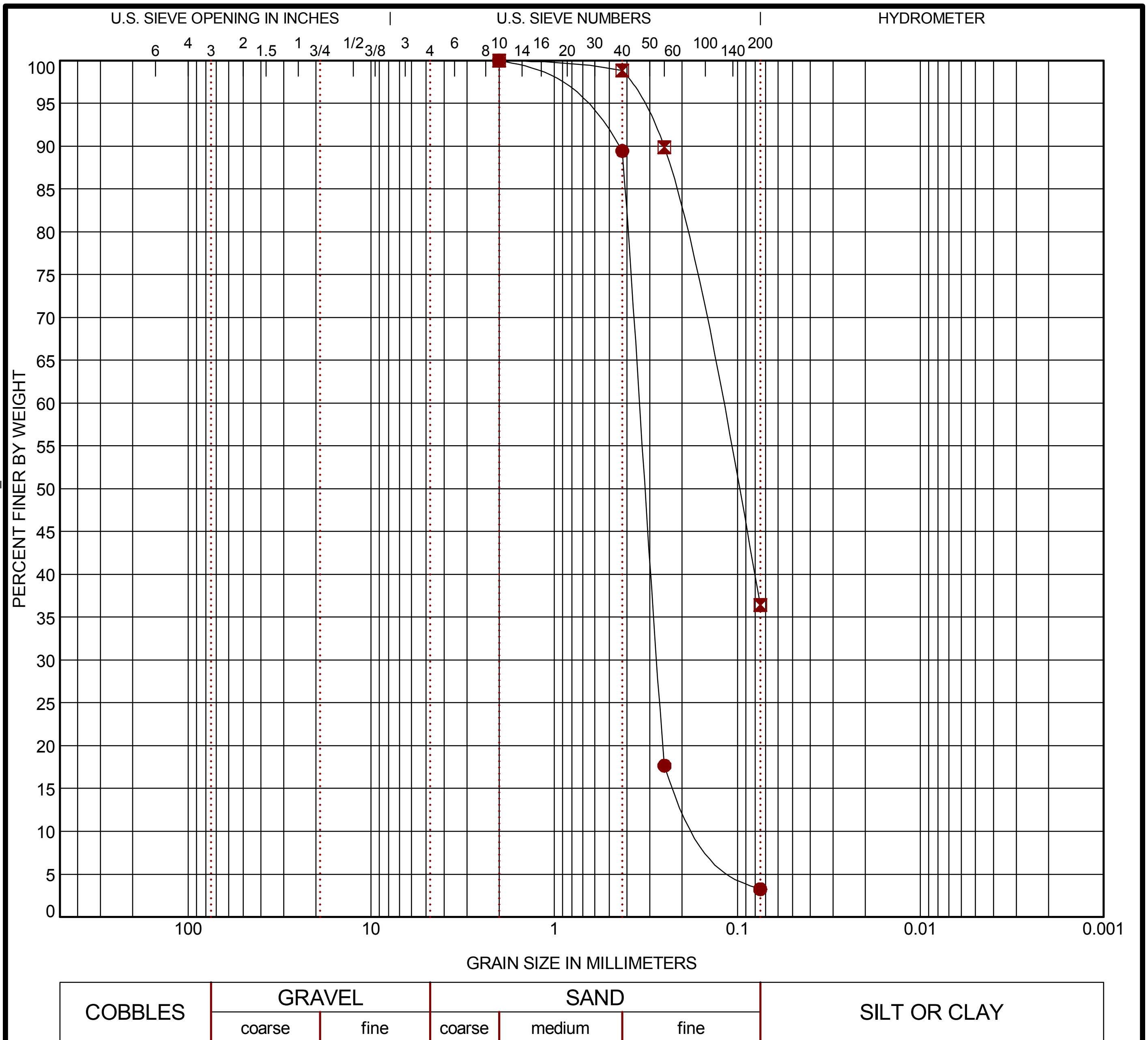
PROJECT NUMBER: EV175097

CLIENT: Capital Projects Division
City of Alexandria, Virginia

EXHIBIT: B-2

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



	Boring ID	Depth	USCS Classification	AASHTO Classification	WC (%)	LL	PL	PI	Cc	Cu
●	TB-1 H	15 - 17	POORLY GRADED SAND (SP)	A-3 (0)	4	NP	NP	NP	1.66	2.59
☒	TB-2 H	48.5 - 50	SILTY SAND (SM)	A-4 (0)	37	NP	NP	NP		

	Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Fines	%Clay
●	TB-1 H	15 - 17	2	0.342	0.274	0.132	0.0	96.8		3.2	
☒	TB-2 H	48.5 - 50	2	0.128			0.0	63.6		36.4	

PROJECT: 116 South Henry Street

SITE: 112 South Henry Street
Alexandria, Virginia

Terracon
4899 Prince William Pkwy
Woodbridge, VA

PROJECT NUMBER: EV175097

CLIENT: Capital Projects Division
City of Alexandria, Virginia

EXHIBIT: B-3

APPENDIX C

SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING

Auger	Split Spoon
Shelby Tube	Macro Core
Ring Sampler	Rock Core
Grab Sample	No Recovery

WATER LEVEL

- **Water Initially Encountered**
- **Water Level After a Specified Period of Time**
- **Water Level After a Specified Period of Time**

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	**Hand Penetrometer**
(T)	**Torvane**
(b/f)	**Standard Penetration Test (blows per foot)**
(PID)	**Photo-Ionization Detector**
(OVA)	**Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.			**CONSISTENCY OF FINE-GRAINED SOILS** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength, Qu, tsf**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**
Very Loose	0 - 3	0 - 6	Very Soft	less than 0.25	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	0.25 to 0.50	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium-Stiff	0.50 to 1.00	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	1.00 to 2.00	8 - 15	10 - 18
Very Dense	> 50	≥ 99	Very Stiff	2.00 to 4.00	15 - 30	19 - 42
			Hard	> 4.00	> 30	> 42

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

Terracon

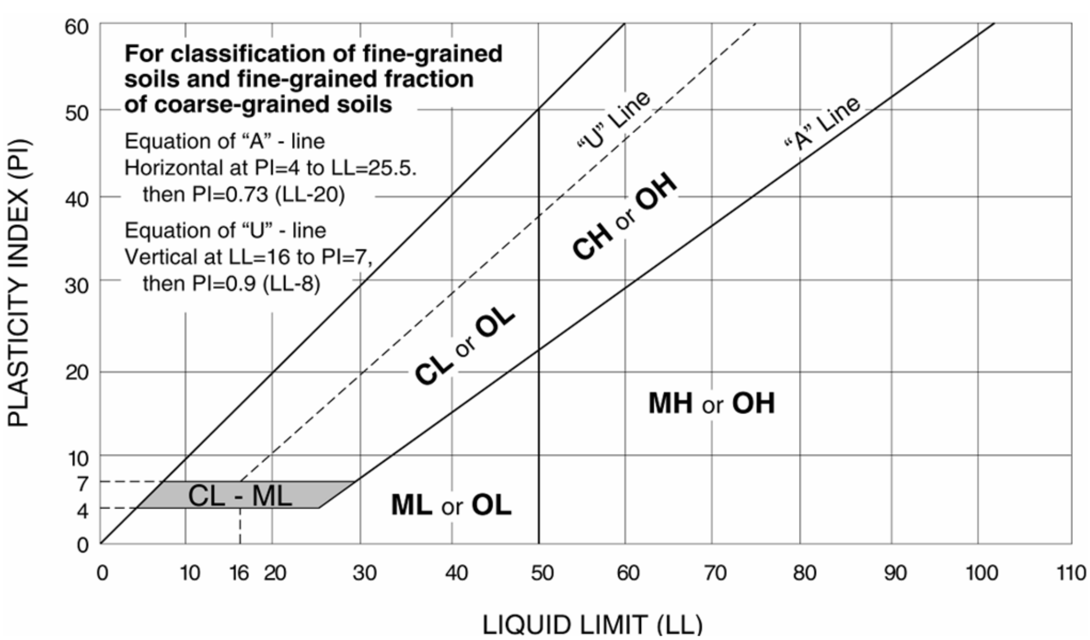
UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	**Group Name** [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu ≥ 4 and 1 ≤ Cc ≤ 3 [E]	GW	Well-graded gravel [F]
			Cu < 4 and/or 1 > Cc > 3 [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu ≥ 6 and 1 ≤ Cc ≤ 3 [E]	SW	Well-graded sand [I]
			Cu < 6 and/or 1 > Cc > 3 [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G,H,I]
			Fines classify as CL or CH	SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]	CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [K,L,M,N]
					Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K,L,M]
			PI plots below "A" line	MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [K,L,M,P]
					Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10} \quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.



Terracon